

Practical Strategies for teaching Adult Numeracy

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Sharing Attitudes to Maths

Think (1 Min) :

- ▶ Have any of your students talked to you about their attitudes to maths?
- ▶ What have they said?
- ▶ Are there other clues to indicate their feelings?
- ▶ **Think → Pair → Share**
- ▶ *Oral rehearsal*

Attitudes to teaching numeracy

- ▶ What I remember most about my maths classes when I was at school is

Sharing Attitudes to Maths

- ▶ Traditionally, school maths has been taught as:
 - Silent
 - Competitive
 - Repetitive
 - Seemingly meaningless
 - Abstract
- ▶ For many it becomes an unpleasant experience that makes them anxious
- ▶ ‘Maths Anxiety’ very common in adults

Sharing Attitudes to Maths

- ▶ When **anxiety** enters **common sense** flies out the window
- ▶ Some examples witnessed
 - EO officer – % calculation
 - Factory trainee – average calculation

Maths anxiety

Described by Sheila Tobias as:

.. the **panic**,
helplessness
and **mental disorganization**
that arise among some people
when they are required to
solve a mathematical problem.

[Or engage with maths related thinking]

Maths anxiety

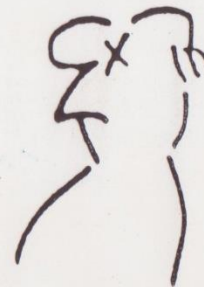
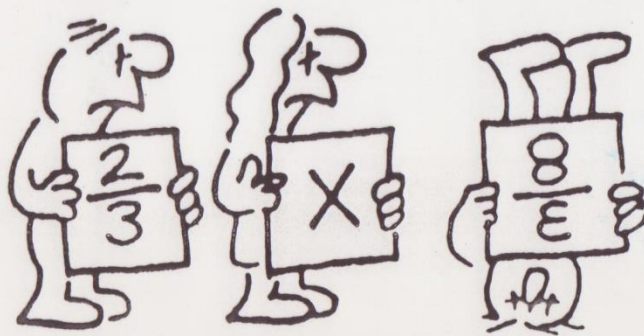
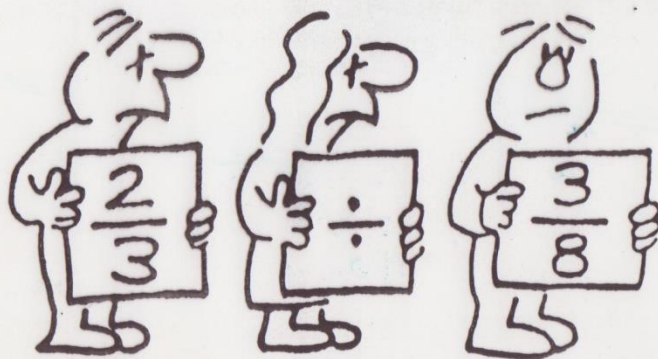
- ▶ Related to different levels of maths for different people
- ▶ **Invisible numeracy** – tacit numeracy – the maths you use every day – not thought of as maths
- ▶ **Maths** – relates to what you **cannot** do

Maths anxiety

Maths anxiety is associated with
lack of meaning
in maths at school,
never understanding
what or why you were doing things.

Rules and formulae without meaning

TURN THE SECOND
FRACTION UPSIDE DOWN



Maths anxiety

- Findings from workplace numeracy research interviews with workers
- Negative feelings about school maths
- Most about seeming **irrelevance of high school maths** – as one young woman said:
 - *“the teacher couldn’t relate it to real life”.*
 - **enjoyed percentages**, but **hated algebra** because she saw it as useless for life
 - *“I only did maths to year 10, I couldn’t stand it - fractions and **all that stuff** - I didn’t pay attention. But I **did do accounting - didn’t mind that.**”*
 - now uses formulae at work – but not named ‘algebra’

Maths anxiety

- ▶ Maths anxiety should not be ignored – can cause
 - Headaches & nausea
 - Panic attacks
 - Avoidance of numeracy classes
- ▶ Common beginnings of anxiety in adult numeracy students
 - Fractions
 - Long division
 - Speed tests – tables races, ‘mental’
 - Algebra

Numeracy not mathematics

- ▶ Numeracy teaching should use **different teaching methods** from those experienced during school maths classes
- ▶ Not abstract - but
 - Connected
 - Visual
 - Hands-on
 - **Linked to language**
- ▶ Not silent & competitive - but
 - Cooperative
 - **Rich in interaction and discussion**

Why interaction & discussion

Benefits of interaction and discussion fall into two categories

- ▶ **Social benefits** – helping create relaxed & positive classroom culture
- ▶ **Cognitive benefits** – helping with learning

Why interaction & discussion

- ▶ Social benefits of interaction between students:
 - Breaks down expectation of silent maths classroom
 - Helps create friendly and relaxed atmosphere
 - Encourages interaction between groups of students
 - Inclusive for potentially isolated students
 - Creates habit of assisting other students – even when not doing group activity

Why interaction & discussion

Group collaboration on a task:

- ▶ Expands range of interactive roles students can take on
- ▶ Increase the means of actively contributing and signalling participation:
 - *Explaining to late-comers*
 - *Keeping group on track*
 - *Asking clarifying questions*
 - *Contributing different types of knowledge* – mathematical or everyday, society-related knowledge

Why interaction & discussion

Group collaboration also encourages students to attempt more difficult tasks and to persevere longer with tasks

Why interaction & discussion

- ▶ Discussion encourages:
 - Exploration of ideas
 - Use of maths related language
 - Will discuss language a lot during the program

Why interaction & discussion

Maths-related language:

Just as a person in a foreign country
finds herself inarticulate
and powerless
without access to the native **language**,
students are disempowered
by the inability to express themselves
in mathematics.

Why interaction & discussion

- ▶ Promoting discussion is not just asking students to work together on practice exercises
- ▶ Discussion is fostered through activities specifically designed for pair and small group participation
- ▶ They often rely on movable pieces in the centre of table
- ▶ These encourage all in the group to share
- ▶ Not paper and a pencil that one person will take

Why interaction & discussion

- ▶ It takes **courage** to try new methods with adult students
- ▶ Especially those from other cultures (or in developing countries)
- ▶ It is worth the effort!
- ▶ They love them.

Activity models

- ▶ Will look at several types of activity structured to encourage interaction and discussion
- ▶ Call them '**Activity Models**' because they are simple, flexible structures adaptable for a variety of learning purposes
- ▶ Easy to create others to suit your students' needs

‘Cooperative Logic’ model

- ▶ Small group problem solving activities
- ▶ Rely on pieces on the centre of the table
- ▶ Specific rules to encourage sharing information
- ▶ Tightly structured so all students participate

‘Cooperative Logic’ model

Cooperative Logic procedure:

- ▶ Each student is given one or more clue cards
- ▶ One by one they read their clues aloud
- ▶ Others gain their information by listening
 - They must not take and read someone else’s card
 - Cards can be read aloud as often as needed
- ▶ Together the group members use the clues to move the pieces until the problem is solved

‘Cooperative Logic’ model

Many Cooperative Logic problems in *Building Strength with Numeracy* (VALBEC website)

- ▶ ‘Getting Started’ Section
 - Focus on position, location & direction language and meaning
 - Varying level of difficulty
- ▶ ‘Exploring Numbers’ Section
 - *What’s the Secret Number*
 - Series of 5 secret Numbers – focus on language of number properties and place value
- ▶ Will also be used in Decimals Section
 - *What’s the decimal number*

‘Cooperative Logic’ model

Extending Cooperative Logic problems for language practice

- ▶ In pairs write two sentences eg *the ... is ... of the*
- ▶ Teacher created close exercises modelled on clues
 - use east, south west, opposite, beside
- ▶ Small group exercise write a new problems for others to solve – modelled on series just done
 - eg maps, build its, numbers, decimal numbers



Building Strength With Numeracy

Teacher Resource – Developed 2012/13

- ▶ Free to download
- ▶ VALBEC website: www.valbec.org.au
- ▶ Or just search VALBEC



Building Strength With Numeracy

- ▶ Intention to make available
 - Old favourites activities from prior publications :
 - *Strength in Numbers*
 - *Mathematics: A new beginning*
 - *Numeracy on the line*
 - Revised & updated
 - New Practice Sheets added

- ▶ Newly developed activities arising from more recent teaching experience



Building Strength With Numeracy

Currently 5 Sections:

- ▶ Getting Started
- ▶ Exploring Numbers
- ▶ In the Head Calculations
- ▶ Fractions
- ▶ Percentages
- ▶ Decimals
- ▶ Measurement

Getting started with a group

- ▶ **‘Classroom Culture’** – established early
- ▶ Adult students very quickly become habituated in:
 - Where they sit
 - Who they talk to
 - What they expect to happen in the class
- ▶ Once a ‘culture’ established – harder to change
- ▶ **Start as you hope to go on** – use a variety of activities early in the course
 - Individual –practice – Interactive
 - Pairs – Small groups
- ▶ Move people around for some activities to ensure they interact with many others in early stages

Getting started with a group

From the very beginning a numeracy class should:

- ▶ Provide opportunity for students to discuss attitudes to maths
- ▶ Allow all students to experience some success with maths
- ▶ Include some non-threatening pair and group work
- ▶ Use games and other fun activities
- ▶ Provide opportunities for you to observe what students know
 - and respect that as a place to start teaching

Sharing Attitudes to Maths

Write whatever comes into your head to finish these sentences.

- ▶ Maths makes me feel
- ▶ Maths at school was
- ▶ I'm good at
- ▶ I've never been able to
- ▶ I'd like to learn how to

Getting started with a group

- ▶ **Invisible mathematics** doesn't alleviate negative self image
- ▶ **Negative feelings** impact on confidence to use mathematics.
- ▶ Also on willingness (or resistance) to try to learn more mathematics.
- ▶ **Need to help learners recognise the numeracy skills they already use** and other skills that they need to learn

Getting Started with a group – Respecting prior experience

- ▶ Important **adult learning principle**: *‘Start by building on students’ existing knowledge’*
- ▶ Look for what students **can do** – not what they cannot do
- ▶ Use activities that allow you to observe what students know already while they work individually and together

Getting Started with a group – Respecting prior experience

What students know is not always easy to find out before classes:

- ▶ Intake interviews often focus on literacy
- ▶ or just enough numeracy to find a rough ‘level’
- ▶ Initial testing a negative start
- ▶ Provokes unnecessary anxiety

Observation of non-threatening activities helps with this

- ▶ Pair, small group or individual

Respecting prior experience

- ▶ Make records of observations where possible
- ▶ This form of assessment is termed **Informal Assessment**.
- ▶ Two kinds
 - **Initial assessment** – at the beginning of a course or program
 - **Formative assessment** – during the course
 - to keep you informed of progress
 - To assist in planning teaching

Respecting prior experience

Informal assessment

- ▶ Helpful to keep complete records
- ▶ Ideas for record keeping described in:
 - ▶ *Rethinking Assessment – Strategies for holistic adult numeracy assessment*
 - ▶ See handout

Getting Started with a group – Respecting prior experience

Game 1 – Multidigit

As you participate in this game think about:

- What you might be able to observe if your students were playing this
- How would it help you as a teacher?

► Discuss

- Think – pair – share

Getting Started – Games

- ▶ Observing students' familiarity with numbers
 - *Multidigit*
 - A game students enjoy
 - Knowledge and language of place value
 - Addition skills
 - Estimation skills
 - Simple awareness of probability*
- ▶ Students (and teachers) from Timor–Leste loved this
- ▶ Also good for starting a session
- ▶ Found in '*Getting Started*' section of *Building Strength with Numeracy*
- ▶ Other games of similar level in *Strength in Numbers* and *Breaking the Maths Barrier*

Getting Started – Games

- ▶ Can also use commercial card, dice or board games– as long as some numeracy skills involved. For example:
 - number recognition
 - counting
 - addition
 - estimation
- ▶ Also can introduce basic ideas and language related to **probability or chance**
 - 1 out of 6 , 1 in 6, 1 in 4, 1 in 52, ‘1 in a million’ ...

Getting Started – Games

Criteria for choosing games

- Short time to play a round – keep students' interest
 - Simple rules – can concentrate on the skills involved
 - Strong element of chance – more skilled not always winners
 - Practice relevant skills
 - Develop new skills through discovery – later
- ▶ ‘*How close can you get*’ – subtraction practice – using playing cards – *Breaking the Maths Barrier*

Respecting prior experience


Number sorting activity

Examples of students responses
and teachers' observation notes

Number Patterns

- ▶ Good introductory activity:
 - For mixed group of new students
 - Don't require language
 - Students can progress at own rate
 - Have many practice sheets ready
- ▶ Found in '*Exploring Numbers*' Section of *Building Strength with Numeracy*
- ▶ Easy to create your own

- Fill in the missing numbers
- Show the rule you used with an arrow

1.	1	2		3	4	___	___	7	8	___	___
2.	2	4	6	8	10	___	___	___	___	20	
3.	5	10	15	20	25	___	___	___	___	50	___
4.	10	20	30	___	___	___	___	___	___	100	___
5.	20	40	60	80	100	___	___	___	___	___	___
6.	___	25	35	45	55	___	___	___	___	___	___

Number Patterns

- All work on same task but progress at different rates
 - Have several sheets ready
 - mixed operations
 - graded level of difficulty
- Allows teacher to observe:
 - How far/fast each student can progress
 - Which operations easy/difficult for each student
 - Can also collect to analyse further

Number Patterns

- ▶ Mixed operations examples
- ▶ (from *Mathematics a New Beginning*) – 3 sheets – give out 1 at a time
 - 1) 2, 5, 8, –, –, –
 - 2) 1, 7, 13, –, –, –
 - 3) 100, 80, 60, –, –, –
 - 4) 8, 4, 2, –, –, –
 - 5) $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$, –, –, –
 - 6) 0.2, 0.4, 0.6, –, –, –
 -
 - 9) 1, 2, 4, 5, 7, 8, –, –, –

Number Patterns

- ▶ Have included many practice sheets in *Building Strength with Numeracy*
- ▶ 8 patterns on each
 - Graduated in difficulty
 - Some with time
 - Some with money
- ▶ Also suggestion that students create their own *Guess my pattern* – for other students to try
- ▶ You give each student a different number to start with

Number Patterns

Other advantages and uses:

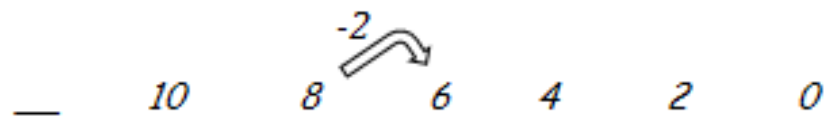
- ▶ Use as an alternative form of practice exercise
- ▶ Create patterns to suit your students' needs
- ▶ Can be simple or require more thought as they progress

- Counting in tens _ 50 60 70 80 _ _ _
- Adding or subtracting time _ 9.40 9.45 9.50 9.55 _ _
- Adding money _ \$1.50 \$2.00 \$2.50 \$3.00 _ _
- Adding decimals _ 4.8 5.1 5.4 5.7 _

Number Patterns

Other advantages and uses:

- ▶ Use to illustrate the 'inverse' or opposite nature of operations
- ▶ Addition & subtraction
- ▶ Multiplication and division

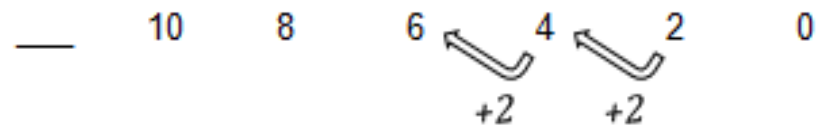


Ask: *Do you know what number would go here?*

Help students to visualise the opposite pattern by suggesting they start at the other end (0, 2, 4, 6, etc.).

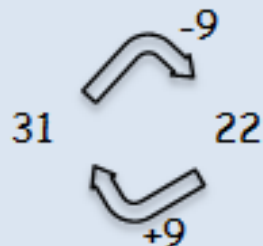
Ask: *What would the rule be going this way?*

Draw arrows under the numbers to assist students to see that the next number will be 12:



This idea can be used later to encourage students to check their subtractions by adding.

For example 31- 9



If a student's answer was 23, the check ($23 + 9 = 32$) should highlight a mistake.

Matching & sorting models

- ▶ Allow you to observe what students know already while they work together
- ▶ Important **adult learning principle**: *‘Start by building on students’ existing knowledge’*
- ▶ Look for what students **can do** – not what they cannot do

Matching & sorting models

- ▶ Rely on pieces on centre of table
- ▶ **Two kinds:**
 - ▶ Simple matching of pairs of cards
 - ▶ Sorting several cards into groups that match
- ▶ **Simple pair matching**
 - ▶ Most simple and non-threatening of all
 - ▶ Answers are all on the table to be found
 - ▶ Alleviates anxiety
 - ▶ Process of elimination allows students to start with the easiest or most familiar

Matching & sorting models

Matching activities

- ▶ Were very well received in Timor-Leste workplace training
- ▶ Learners often took photos at the end as a record of solutions
- ▶ The success of the model inspired me to create more
- ▶ Many ideas for matching and sorting activities are included in new resource: *Building Strength with Numeracy* (VALBEC website)





Matching & sorting models

Useful to:

- ▶ Introduce a new topic
- ▶ Revise previously learned material
- ▶ Change energy during a session
- ▶ Provide opportunity for student interaction
- ▶ Allow for informal assessment

Matching & sorting models

When using matching & sorting activities:

- ▶ Encourage students to explain their thinking to each other
- ▶ Each should be able to explain why cards are put together
- ▶ Opportunity for you to ask questions like:
 - ▶ *‘Can you explain why you put this here ...?’*
 - ▶ *‘Are there any others ...?’*
 - ▶ *‘Which were the easiest ...to place?’*

Matching & sorting models

Extending the models for extra learning:

▶ Leaving a blank

- Put in one card with only a blank as pair
- Learners create their own pair
- Requires closer look at other cards – more thought

▶ Providing open ended blanks

- Put in several blank pieces
- Get learners to complete a group
- Or create their own pairs or groups

▶ Use as a springboard for discussion

- See Suggested Procedures and practice sheets in *Building Strength with Numeracy*

Matching & sorting models

- ▶ Examples from *Building Strength with Numeracy*
- ▶ *Matching Common Fractions:*
 - Uses blank cards – to encourage more detailed examination of the other cards
 - Provides an open-ended component
- ▶ *Sorting fractions of ...*
 - Spring board for introducing new way to look at fractions

A hands on approach to fractions

- ▶ Fraction concepts necessary for all numeracy students
- ▶ Basis of decimals and percentages
- ▶ Part of our language and culture
- ▶ If observations of matching show students don't know the concepts – this is a good way to start
- ▶ Very effective for me in T-L

‘Hands on’ materials

- ▶ For variety of topics
 - Arithmetic calculations & Fractions
 - Measuring & developing formulae
 - Developing spatial language
- ▶ Always using the materials to enhance meaning – to make better sense
- ▶ Particularly effective with visual and tactile learners

‘Hands on’ materials

Old adage attributed to Confucius

I *hear* and I forget
I *see* and I remember
I *do* and I understand

Common rationale for using hands on materials for learning

‘Hands on’ materials

- ▶ When using hands on materials for the first time with adult students you do need to be tactful
- ▶ Explain from perspective of different learning styles
 - Lots of research shows that people learn in different ways ... visual ... etc
 - Well known now .. but not in past
 - Schools not always able to provide for all ...
 - Just taught people with rules .. not understanding why

‘Hands on’ materials

- ▶ Adults do better if they *understand why* they are doing something
- ▶ These ... are another way to look at ...
- ▶ Have been used by lots of adult students in Australia
- ▶ Found they make the ideas/method clearer ... help *understanding* instead of just rules

Hands on fractions

Small groups or pairs

- Empty one of the fraction kits on to the table.
- Make up *single coloured* circles and display them in front of you on the table.
- Use the circles to help you fill in the chart of fraction names and symbols.
- Think about how you would explain the name and symbol to someone that did not know.

Colour chart for fractions

Number of pieces	Colour of piece	Fraction symbol	Written name
One	Red	$\frac{1}{2}$	One half
One	Green	$\frac{1}{3}$	One third
One			
One			
One			
One			

Hands on fractions

- ▶ What if we have more than one piece?
- ▶ Write the symbol and name for
 - Two green pieces
 - Three pink pieces

$2/3$

Tells you?



$2/3$



Tells you?

Hands on fractions

- ▶ Use the fraction pieces to make these fractions on the table in front of you.

$\frac{3}{12}$; $\frac{1}{4}$; $\frac{3}{8}$; $\frac{3}{5}$; $\frac{1}{2}$

- ▶ Decide which fraction is the biggest
- ▶ Which is the smallest?
- ▶ Write the symbols for the fractions I hold up:

Hands on fractions

About fractions of other shapes

- ▶ Circles used at first because clear when you have the whole thing
 - Can represent pizza, cake, pie, flat bread
- ▶ Unlike rectangle – eg chocolate bar – arbitrary how long it is – not so clear when you see the whole
- ▶ But need to model with other shapes as well
 - BSWN has other shapes on practice sheets

Hands on fractions

- ▶ A side story
 - A fraction piece and a clock
 - So telling the time in English might make sense after all
- ▶ Fractions are part of our culture and language
- ▶ A good reason for teaching the meaning, names and symbols
- ▶ But only as far as appropriate

Hands on fractions

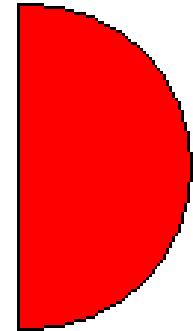
Ordering fractions

- Take 1 piece of each colour
- Arrange them from smallest to biggest
- Write the symbols in the same order on a piece of paper.
- What can you tell me about the *numbers* in the fractions and the *size* of the pieces?
- Can you *explain* to someone else why this happens?

Hands on fractions

Using the pieces make as many single coloured shapes the same as one half

$1/2$ is the same as:



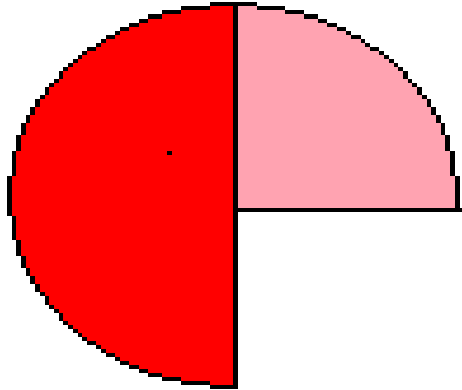
Hands on fractions

- ▶ All different names for the same piece
- ▶ One fraction can have many different names
- ▶ These are sometimes called '*equivalent*' fractions
 - Only for those who need this level of knowledge
 - Don't 'mathematise'
- ▶ Can you think in terms of slices of a cake or pizza to make sense of this 'equivalence'
- ▶ Could you predict $\frac{?}{6}$; $\frac{?}{20}$; $\frac{?}{100}$;

Hands on fractions

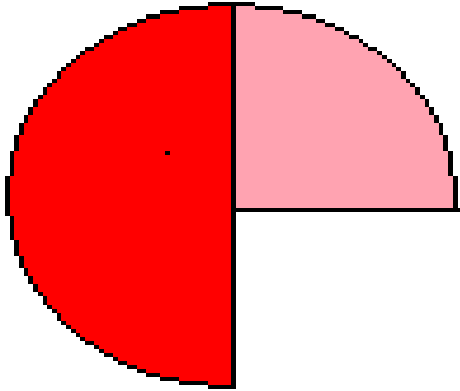
- ▶ Some fractions very important in adult world
 - hundredths
 - tenths
- ▶ Sometimes useful to introduce these special fractions early
- ▶ Adults, unlike children, can't wait for years to learn about them
- ▶ See ideas & templates in BSWN

Hands on fractions



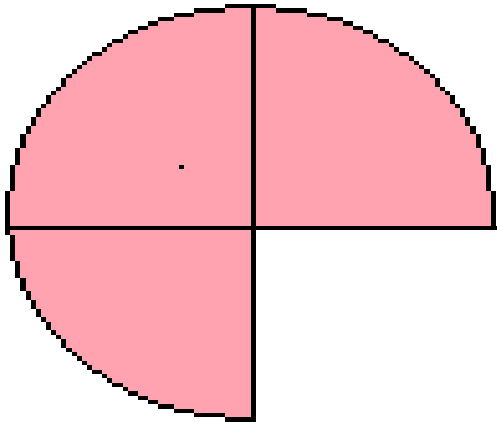
- ▶ This fraction is not 2 halves nor is it just a collection of quarters quarters.
- ▶ What can we name it?

Hands on fractions



- ▶ We can only add fractions together when they are the same kind

Our eyes imagine the half as 2 quarters



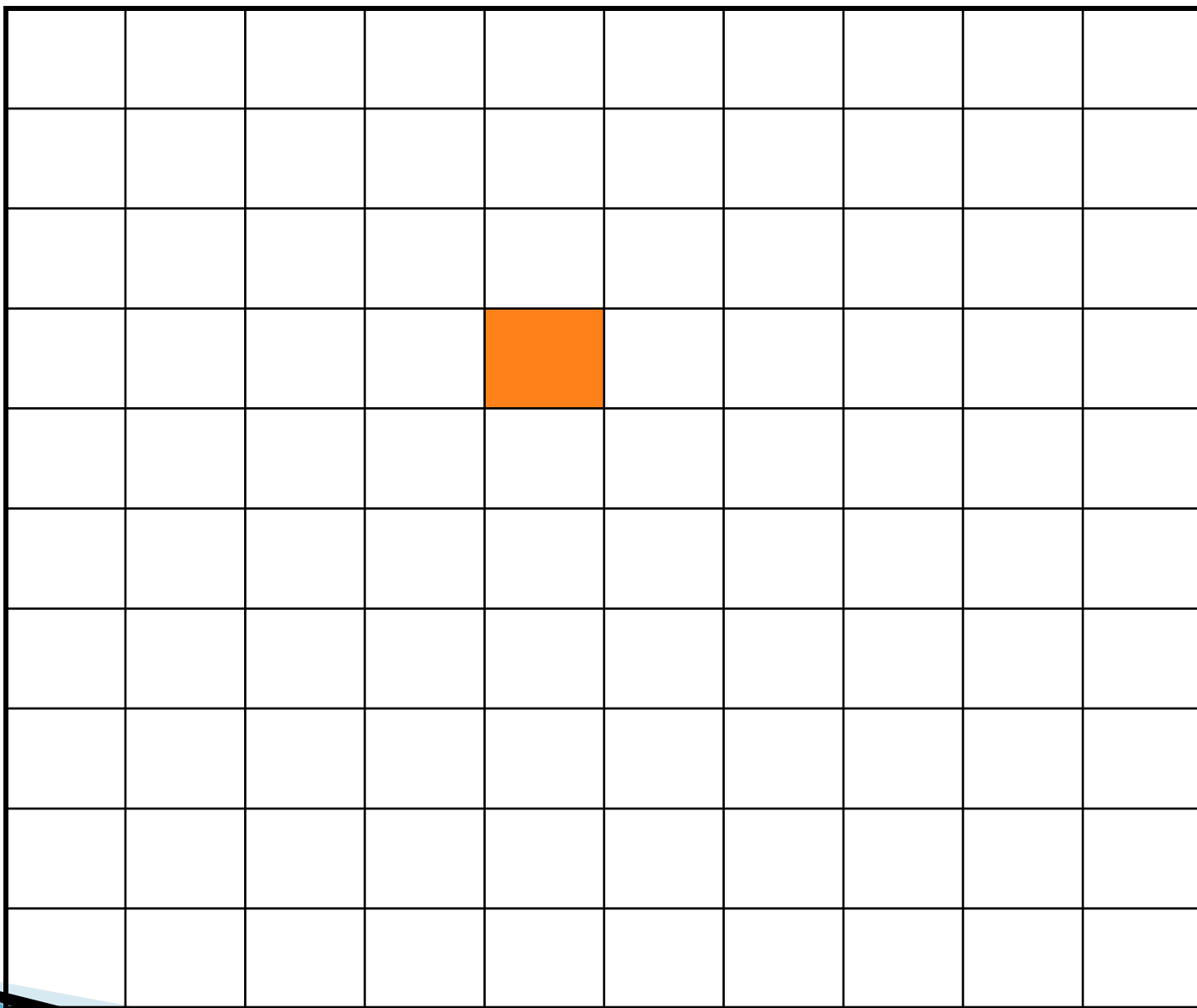
$$\frac{1}{2} = \frac{2}{4}$$

is an example of creating equivalent fractions –
now we can add them together

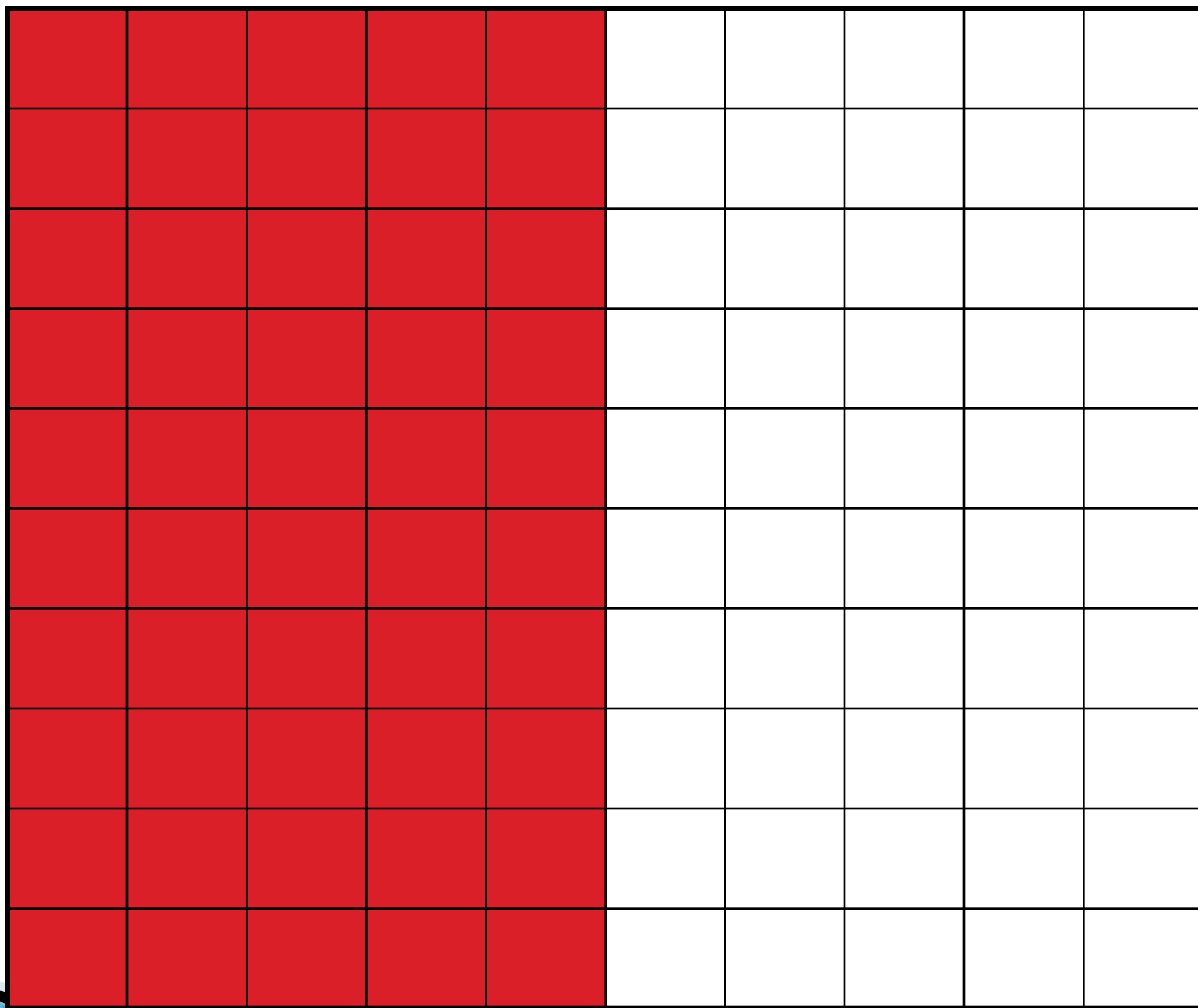
$$\frac{1}{2} + \frac{1}{4} = \frac{2}{4} + \frac{1}{4} = \frac{3}{4}$$

$$\frac{1}{100}$$

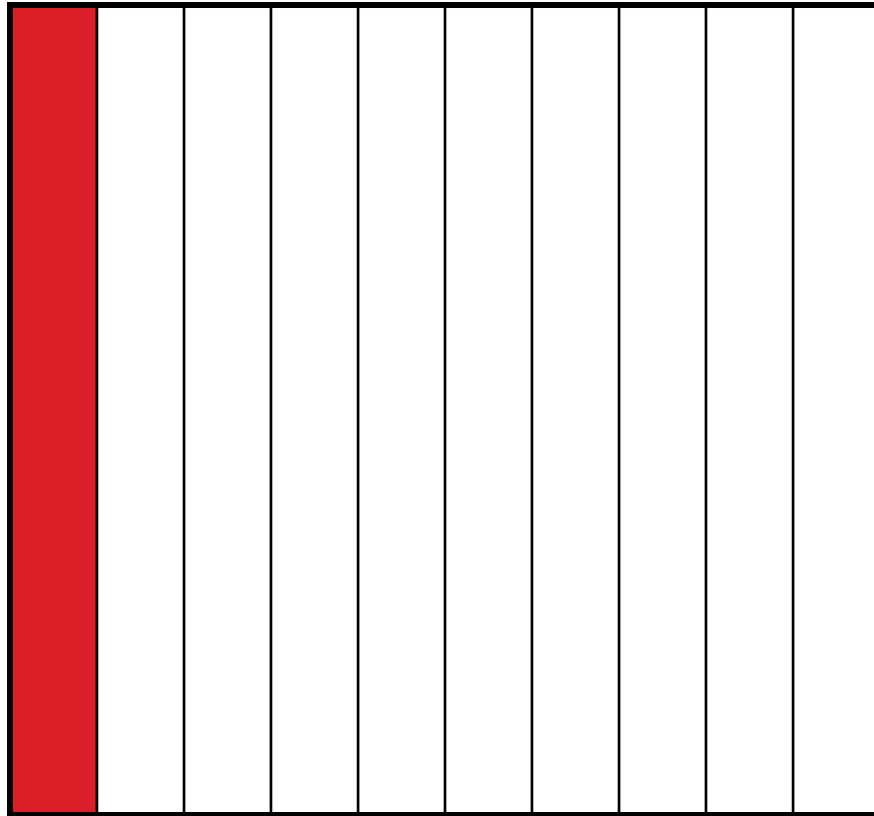
= 1 %



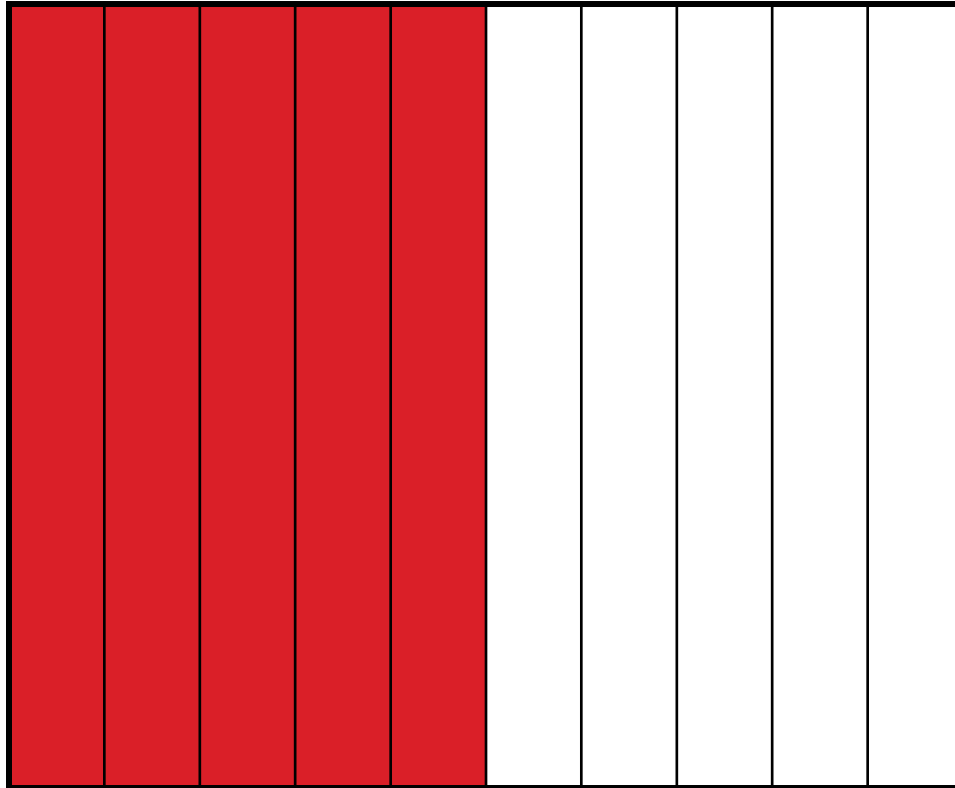
$$\frac{1}{2}$$
$$\frac{50}{100}$$
$$= 50 \%$$



$$\frac{1}{10} = 0.1 = 10\%$$



$$\frac{1}{2} = \frac{5}{10} = \bullet 5 = 50\%$$



Hands on fractions

- ▶ For those needing more detail
- ▶ Equivalent fractions can also be modelled with folded paper
 - $\frac{1}{2}$ – shaded
 - Fold again – what name? – write it down
 - Repeat & repeat
 - Ask *‘can you see a rule in this pattern?’*
- ▶ Repeat with different fractions such as $\frac{1}{3}$ or $\frac{1}{5}$ to start with
 - Students don’t always see quite the same rule we do
 - Try $\frac{2}{3}$ or $\frac{2}{5}$ to go further

Hands on fractions

Fractions of a number or quantity

- Another aspect of understanding fractions

Small groups

- ▶ Count the coloured paper clips on your table
- ▶ Show me $\frac{1}{2}$ of them?
- ▶ *How could you explain your thinking?*
- ▶ Try same for $\frac{1}{3}$ of the clips
- ▶ $\frac{1}{4}$ or $\frac{1}{6}$
- ▶ What about $\frac{2}{3}$? Or $\frac{3}{4}$?
- ▶ Are you using meaning or rules?

A 'sense' of measurement

- ▶ Important aim of adult numeracy to ensure people have *personal references* or *benchmarks*
 - Familiar things they know the size of
 - In metric units – metres, cms, kgs, litres ...
 - And in units appropriate to their lives or work
- ▶ Can then use these to compare when estimating other measurements
- ▶ Another *difference* between *numeracy* and *mathematics*
 - Teach about the system and the units
 - But also a '*sense*' of measurement

A 'sense' of measurement

- ▶ Activities like Metric mix n' match
- ▶ One way to draw attention to what students already know
- ▶ Encourage them to share and discuss
- ▶ Next activity to help them develop others

A 'sense' of measurement

Activity:

- ▶ 'Experiencing success with metric length'
- ▶ Reference: *Breaking the Maths Barrier*,
Marr, Helme and Tout

Based on original activity:

- ▶ 'Introducing metric length'
- ▶ Reference: *Mathematics: A new beginning*
Marr and Helme
- ▶ Continually enhancing and adapting to circumstances
 - Handout – version for T-L

New activity model:

Guess, estimate & measure

Estimating Metric Lengths:

1. Guess – by looking
2. Estimate – by using hands, arms etc
(or other references for approximating)
3. Measure – using accurate measuring tool

New activity model:

Guess, estimate & measure

Object or dimension	Guess	Estimate	Measure







Guess, estimate & measure

- ▶ Metric /measurement awareness activities
- ▶ Can be useful, effective & enjoyable
 - eg T-L customs department
- ▶ Encourages learners to think about expected result before measuring (or calculating)





Guess, estimate and measure

- ▶ Continued this activity to *guess, estimate and measure*
- ▶ The volume of the carton
- ▶ How many of these cartons would fit into
 - a cubic metre
 - a small shipping container
- ▶ Really important knowledge for their work re collecting correct taxes/levies for goods entering the country
 - good estimates needed to detect incorrect paper work

Estimating volumes

- ▶ Activity to highlight learners' existing knowledge of metric volumes
- ▶ Allows them to share their knowledge and diverse experiences by using everyday household items
- ▶ Personal references – highlighted or created
- ▶ Moving from the familiar to the less familiar extends knowledge
 - Useful knowledge – capacity of spoons and cup
 - For cooking, for medicine doses

Estimating volumes

- ▶ A number of sets of assorted household containers
- ▶ Some likely to be familiar to at least some learners
- ▶ Some not so familiar
- ▶ Different shapes with equal or similar volumes mixed in with others

Estimating volumes

- ▶ Talk to someone else – pair or small group – five minutes
- ▶ Do you have some ‘personal references’ for volume or capacity
 - Items you are familiar with & know their volume
- ▶ Did any help you with this exercise?
- ▶ Are each of your references similar or different types of items?
 - Is there a particular reason for that?
- ▶ Are your students’ familiar products & containers likely to be similar or different from yours?
 - ‘Personal disclosure’ –all adults out of classroom



Large sized set of household containers

- Assorted shapes
- Different items likely to be familiar to different learners as reference

Medium sized set of household containers

- Varying shapes
- Some perhaps familiar as reference
- Cup useful to know later



Small sized set of household items

- Varying shapes
- Varying types

Also shows
cubic centimetres
(cc) for reference
 $1 \text{ cc} = 1 \text{ ml}$

- Spoons useful to
know for future



Two items

- Markedly different shapes
- But the same volume
- Likely to cause 'perturbation'
- *'That can't be right!'* reaction
- Lingers in memory
- Should stimulate conversation re packaging and deceptive practices



Estimating volumes

- ▶ If learners need to learn to use measuring equipment
- ▶ Don't supply answers
- ▶ Take the next step and get them to 'measure' the volumes:
 - Fill with liquid to approximate normal level
 - Use standard:
 - Measuring jugs
 - Measuring cups
 - Medicine glasses

Estimating volumes

- ▶ Not necessary to do all sizes at once
- ▶ Could make one set a small part of session
- ▶ But need enough containers and equipment for all learners to be involved
- ▶ Some teachers ask students to bring in empty containers over period of time
 - Ensures 'familiarity'

Estimating volumes

- ▶ Reflective prompts
 - Short questions for the group to respond to
 - Given to them after an activity
- ▶ Attempt to get students to
 - Review the process together
 - Articulate their thinking
 - Make a joint decision
 - Use language of numeracy
 - Refer to Language in Numeracy Learning PPt

Estimating volumes

▶ Example questions

- What was the most surprising thing you noticed in this set of containers?
- Why do you think you were surprised?
- Have any of your ideas about the volume of containers changed during this activity?

▶ Example responses

- *They looked like they carry the same amounts but they were different*
- *The shape of the bottles are deceptive. Sizes and shapes– tall thin bottle appear to be bigger rather than the others*

Estimating weights

- ▶ Similar activity with mystery weights
- ▶ Wrap variety of objects in thick paper
 - include light, heavy, medium objects
- ▶ Students feel packages to estimate weights
- ▶ Compared with set of 'references' – familiar items such as –
 - 1 kg pack of flour or rice
 - Cake of soap (100g)
 - 500 gram packet of pasta
 - 1 apple, potato

Estimating weights

- ▶ Finally weigh the parcels using variety of common scales
- ▶ Shows how seldom we estimate weight by feel
- ▶ Usually done by sight
- ▶ Provoke conversation about products and quantities we buy
 - possible cultural exchanges
 - eg kgs of rice bought in T-L
 - different units or scales used in other cultures

Estimating volumes & language

- ▶ Reflective prompts
 - Short questions for the group to respond to
 - Given to them after an activity
- ▶ Attempt to get students to
 - Review the process together
 - Articulate their thinking
 - Make a joint decision
 - Use language of numeracy
 - Refer to Language in Numeracy Learning PPt

Estimating volumes & language

▶ Example questions

- What was the most surprising thing you noticed in this set of containers?
- Why do you think you were surprised?
- Have any of your ideas about the volume of containers changed during this activity?

▶ Example responses

- *They looked like they carry the same amounts but they were different*
- *The shape of the bottles are deceptive. Sizes and shapes– tall thin bottle appear to be bigger rather than the others*

Why language?

- ▶ My interest in language began during research into adult students working in small groups
- ▶ Even though they were interested in working together and exploring the questions posed
- ▶ Became obvious they did not have maths related language to express their ideas

Why language?

- ▶ Stimulated reading about language in mathematics classrooms
- ▶ Garth Boomer – influential educator – noticed that mathematics is taught as a unspoken language
- ▶ Teachers were the only ones in the classroom using the language

Why language?

*“There is a sense in which in our culture
Teaching is talking!”*

Michael Stubbs
Education researcher

*“School was all talk of course,
but in a different way.
Being told, not telling”*

Penelope Lively
Author

Why language?

- ▶ Talk in typical maths classrooms is dominated by the teacher
- ▶
- ▶ The teacher, who already knows the language is the one with the ‘opportunity to speak’
- ▶ Students seldom have ‘opportunity to speak’
- ▶ They usually have no encouragement to use the language

Why language?

- ▶ Countless examples in educational research of student teacher interaction in classrooms
- ▶ 2/3 rule – Edwards & Mercer
 - For about 2/3 of the time someone is talking
 - For about 2/3 of the time that talk is the teacher's
 - About 2/3 of the teacher's talk consists of lecturing or asking questions

Why language?

- ▶ Questions usually **closed**
 - ▶ Answers usually short
 - ▶ Instantly **evaluated** by teacher (I R E)
 - ▶ Ignore wrong answers
 - ▶ **Funnel** correct responses
 - ▶ Teacher always controls who speaks
-
- ▶ Adult class displayed very little difference from school maths class in terms of 'classroom talk' and use of language

Typical whole class talk

Teacher

I just want to go over the way you work out some areas .. to see if you've forgotten them or not. So ..

[draws a figure on the board as he speaks]

Area of a rectangle, and this includes squares really, .. that's seven and that's four. How do you work it out?

Students

Seven times four/twenty-eight

Teacher

You multiply it together

Typical 1 on1 teacher–student talk

Teacher

So .. A radius equals half of a diameter.

Student

Mm

Teacher

So if you know the diameter, what's the radius? .. Its half

Student

Hm hm

Teacher

Multiplied by five .. Because its radius, multiplied by radius ..

Student

Uh Huh

Teacher

Does that make sense – the process we did?

Why language?

Short aside:

What is the first thing you think of when you see this word?

‘volume’

Why language?

- ▶ ‘Volume’ – meaning depends on the context in which it is used
- ▶ ‘Volume’ means different things in different contexts (discourses)
- ▶ ‘Discourses’ or contexts give meaning to words

Why language?

- ▶ Different meanings can be confusing to students
- ▶ Teachers need to be aware of this and make links explicitly
- ▶ Spend some time focussing on the language
- ▶ **Concepts** of maths are tied up in the words we use for them

Why language?

During my research:

- ▶ Students were given the opportunity to speak through different types of activities
- ▶ They did not have the numeracy language to express themselves succinctly – the means to speak
- ▶ Could not access terms like ‘volume’
- ▶ Used awkward forms like ‘*carried the same amounts*’

Language focused tasks

The students needed to have some time on tasks which focus on language – not just **doing** sums

What I mean by **language focussed tasks**:

Specific tasks that encourage students to **use** as well as **understand** numeracy related language.

Language focused tasks

Some examples:

- ▶ Create your own clues of a problem task similar to ...
- ▶ Write three sentences to describe...
- ▶ Make a list of *similar* and *different* properties of...
- ▶ Describe what you found out from this activity

Language focused tasks

Other examples:

- ▶ True or False activities
 - Particularly rewriting as a true statement

Getting started: Quick Questions

▶ Quick Questions –

- Set of **five** short questions on separate pieces of paper (flashcards)
- Displayed one at a time to whole group

▶ Useful for

- **Recall** of number facts and tables
- **Practising** shortcut or in head skills
- **Revising** shortcut skills from previous sessions
- Creating **focused start** to a session
- **Changing energy** mid session

Getting started: Quick Questions

- ▶ Excellent focus activity
- ▶ Began for assessment of in-the head calculation head skills In T-L and later checking fact recall – eg tables
- ▶ Became a good way to begin lesson – focus students' attention
 - Can't expect consistent attitude to punctuality
- ▶ Became powerful means to revise or check recent learning before starting lesson
- ▶ Often showed skills which needed revisit before proceeding with planned teaching for the day

Getting started: 10 Questions

▶ Also 10 Questions

- Similar idea
- Given to students on slips of paper
- Can be tailored to individuals
- Given for homework
- Same set repeated several times
- Full explanations for their use; and
- Sets of sample questions for both Quick Questions and 10 Questions techniques in *Getting Started* section of *Building Strength with Numeracy*

Quick Questions:

For 'In the head' calculations

- ▶ Getting in the zone
- ▶ First try to do the calculations on these 'Quick Questions'
- ▶ Don't think too much
- ▶ Just do them in a way that would be natural for you

Getting started: Quick Questions

- ▶ Pairs
- ▶ Talk to person nearest you
- ▶ Compare how you worked out each of the calculations
- ▶ Which were the same?
- ▶ Were any quite different?
- ▶ Any surprises –strategies you hadn't seen before?

‘In the head’ calculations

Refer to ‘in the head’ or ‘back of envelope’ strategies as ‘Tricks of the Trade’ because:

- Often learned at work not school
- Shortcut methods passed on from others
- Learning them makes you feel you’ve been let in on a ‘secret’ or ‘trick’
- Makes you feel empowered
- Like you have learned something really new

‘Tricks of the Trade’

- ▶ Sometimes referred to as ‘**socially situated numeracy**’ – part of our repertoire of social practices or ‘**funds of knowledge**’ (Dave Baker)
- ▶ Knowledge and skills developed in particular ‘**societies**’
 - Workplaces
 - Clubs or networks
 - Communities
- ▶ QCAL → Tutor Tips
- ▶ Dave Baker – ‘Social practices’, numeracy teaching
- ▶ Beth Marr – *Keeping it informal – using connections between social practices and numeracy teaching*

‘Tricks of the Trade’

- ▶ We all have different store of ‘tricks’ or **socially situated numeracy practices** depending on our work, life and social experiences
- ▶ Usually learned from someone else
- ▶ Often interesting to share

Examples:

- Building trade – diagonals of rectangles or 3,4,5 string
- Learned theorems at school – but not appreciated their everyday or ‘social practice use’
- Printing – lots of 100 – 25×4

‘Tricks of the Trade’

- ▶ Many of these techniques are now very useful in modern age
 - to **check** that what comes out of our calculators or computers **makes sense**
 - Is in the right ballpark

‘Tricks of the Trade’

- ▶ Will focus on **shortcut** or **in the head** calculation techniques
- ▶ Skills that are important for checking electronic calculations
 - **we may take these for granted**
 - **numeracy learners may not know them**
- ▶ Some that are empowering **alternatives** to traditional school methods
- ▶ Following from more **instinctive methods** than traditional school maths

‘Tricks of the Trade’

- ▶ Some people invent **their own** in the head techniques
- ▶ Often to **avoid operations** they can't do
 - Such as repeated addition to replace multiplication
 - These people become very quick at adding
- ▶ Sometimes because they didn't move on from concrete strategies
 - Such as using fingers for addition (or multiplication)
 - These people become very quick adding with their fingers

‘Tricks of the Trade’

- ▶ These numeracy students may think that their way has no place in a classroom because it's **not like school maths**
- ▶ It's good to **validate their individual strategies**
 - show they do have a place in a numeracy classroom
- ▶ Then enhance their collection of strategies by introducing new methods

‘Tricks of the Trade’

- ▶ VALBEC → Resources → *Building Strength with Numeracy* → *‘In the head calculations’*

‘Tricks of the Trade’

- ▶ Useful number pairs
- ▶ Foundation for quick addition and subtraction by counting on
- ▶ Based on social practice of giving change
- ▶ More instinctive way of performing subtraction

‘Tricks of the Trade’

- ▶ **Counting On** less prone to error than the school algorithms (formal pen and paper methods)
- ▶ Powerful **back of envelope** technique
- ▶ Especially for those who cannot master other ways
- ▶ Also good for distance and **time calculations**

‘Tricks of the Trade’

- ▶ Refer to Quick Question: 4 things @ \$2.99 each
- ▶ Estimate and adjust – in the head method
- ▶ Useful for quick calculations such as:
 - Cost of multiple items at \$2.99, \$1.98, \$3.99 ...
 - Additions like $\$2.95 + \$5.95 + \$7.95$

'Tricks of the Trade'

- ▶ Estimate and adjust

- ▶ Cost of 4 items at \$2.99 each

estimate

4x\$3

\$12

adjust

– 4 x 1c

– 4c

final

\$11.96

- ▶ Encourage informal approach – not rigid setting out

'Tricks of the Trade'

- ▶ Estimate and adjust

- ▶ Cost of \$2.95 + \$5.95 + \$7.95

estimate

\$3 + \$6 + \$8

\$17

adjust

– 3 x 5c

– 15c

final

\$16.85

See sample from:

Empower Metric: Giving maths a second chance

Everyday Number Sense

Quick Questions to start a session

Example:

- ▶ Revising in the head method of calculating $\frac{1}{2}$ and $\frac{1}{4}$ of quantities
- ▶ Introductory spiel to students
 - learning from observing own teaching
- ▶ *“Want you to practice using this new way*
 - *Even if you **are** good at formal division*
 - *Give this **new way** a try*
 - *I won’t go too fast*
 - *Results private – I **will not** put you on spot by asking”*

Quick Questions to start a session

Note:

- ▶ Emphasis on *change* of method
 - Others not wrong just different
- ▶ Would not spend a lot of time explaining method to a class at beginning
 - Lose focussed start intention with talk talk ...
 - Can have several sets ready if you think they will need more
 - Could use 10 question idea
 - Can also make them up as you need
 - Use board
- ▶ Practice exercises of gradually increasing complexity in BSWN – activity on this skill

Summary of the day

- ▶ Activity models looked at today to encourage interaction & discussion and promote a 'sense of measurement'
 - Cooperative logic
 - Matching & sorting
 - True or False
 - Guess Estimate and Measure
- ▶ Hopefully some useful as they are with your students
- ▶ But also you can use these as a basis to create new activities for the diverse content appropriate for your students

Priorities for second session

- ▶ Activities for exploring percentages – including
 - in the head calculation methods
 - games
- ▶ Methods for teaching decimals
- ▶ Effective use of calculators
 - including estimation
- ▶ Making sense of algebra and formulae
- ▶ Problem solving activities – space, shape and number
- ▶ Other requests?